Adapter-directed display systems

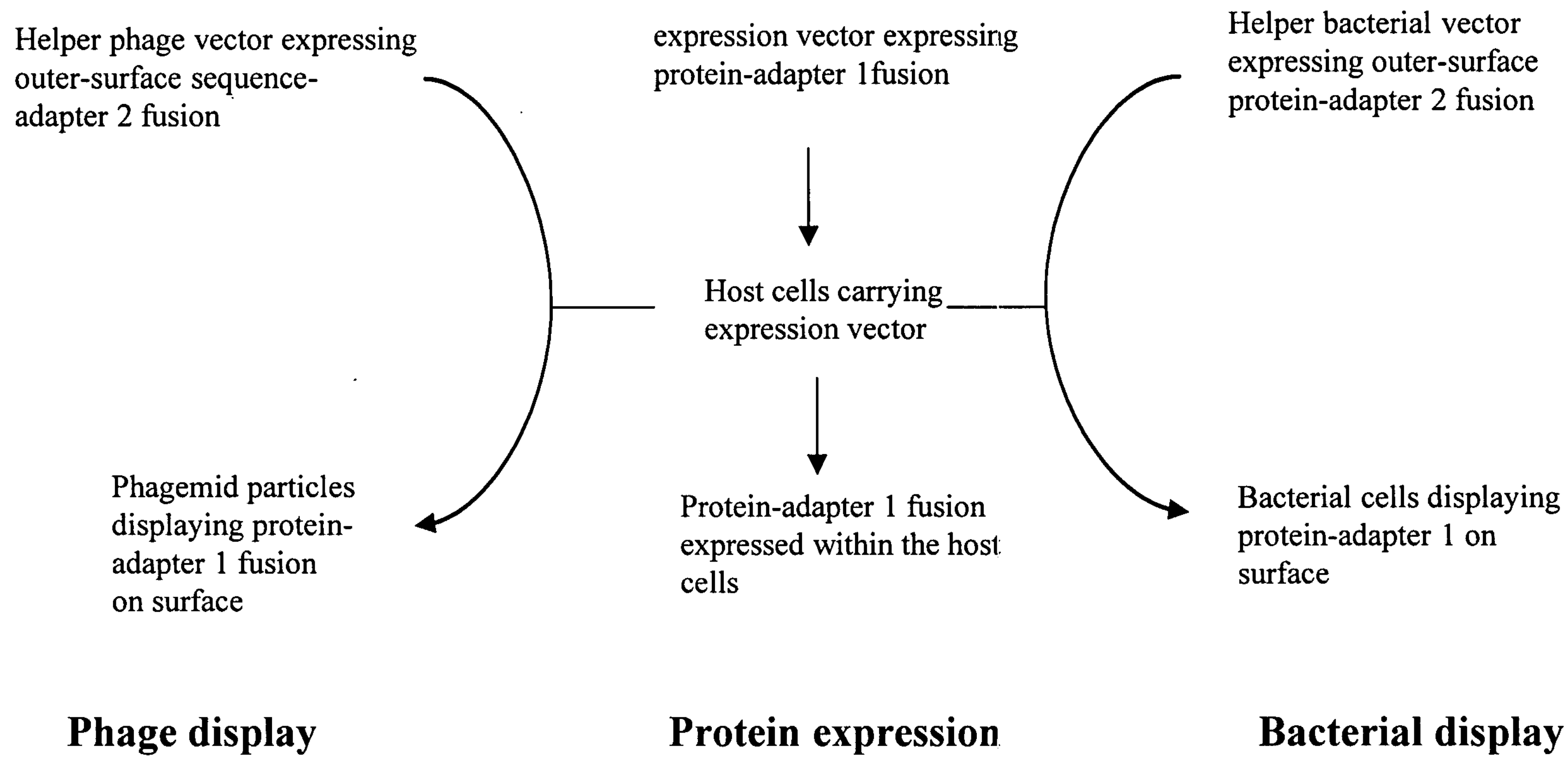


Fig. 1

10033399.110201

KO7kpn phage Screening by ELISA

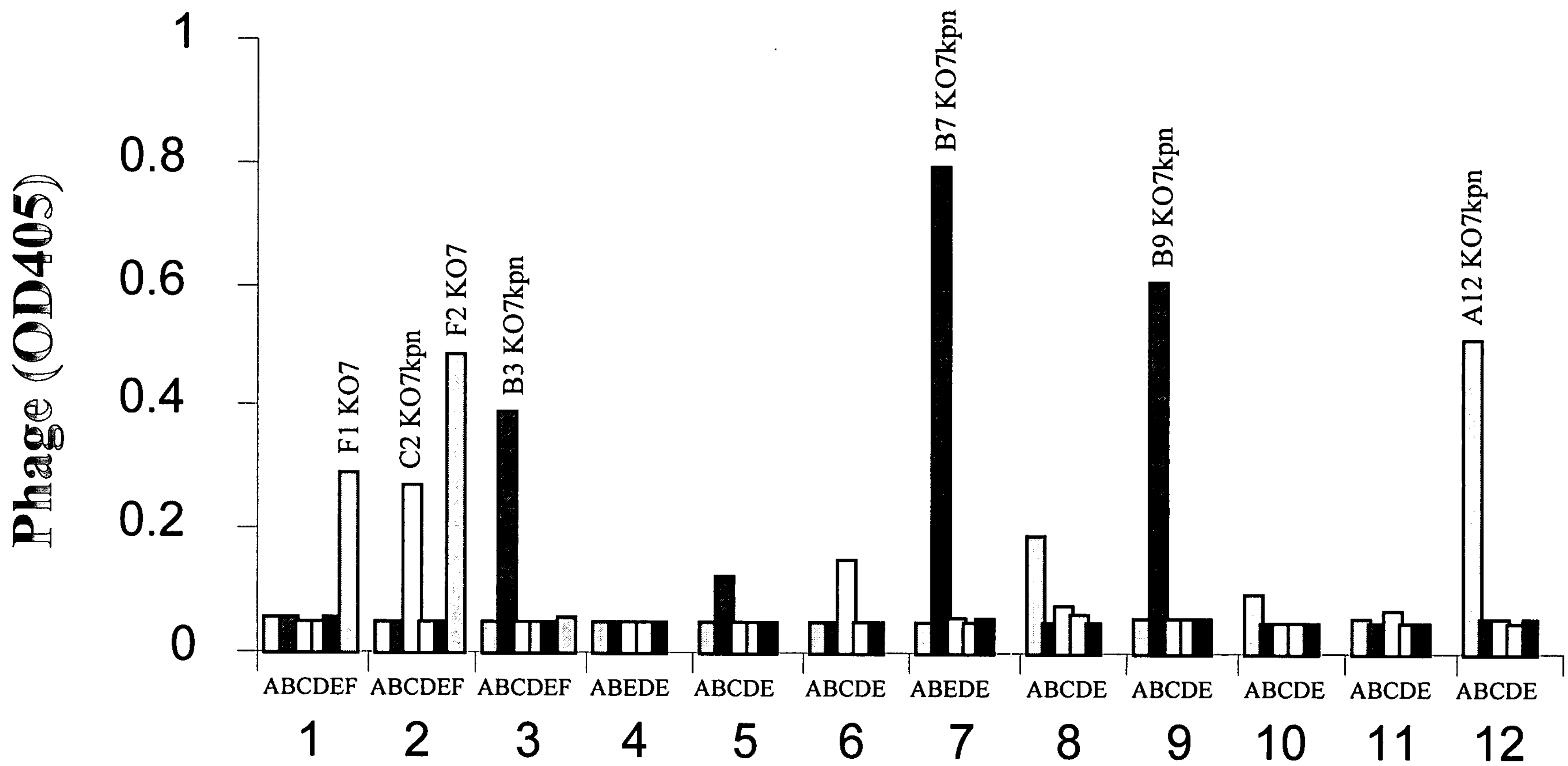


Fig. 2

KO7kpn helper phage Vector

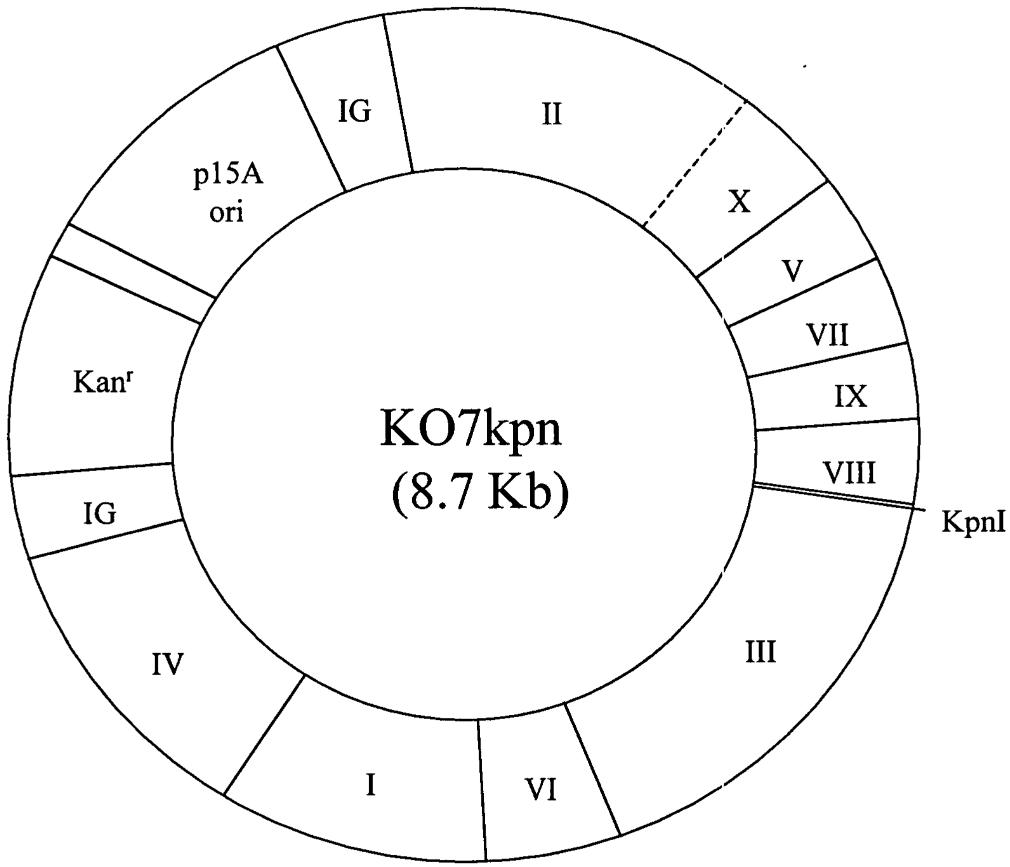


Fig. 3A

Gene III leader sequence in KO7 helper phage

```
GTG AAA AAA TTA TTA TTC GCA ATT CCT TTA GTT GTT CCT TTC TAT TCT CAC TCC GCT
 V   K   K   L   L   F   A   I   P   L   V   V   P   F   Y   S   H   S   A
```

Gene III leader sequence in KO7kpn helper phage

```
                                              KpnI
GTG AAA AAA TTA TTA TTC GCA ATT CCT TTA GTG GTA CCT TTC TAT TCT CAC TCC GCT
 V   K   K   L   L   F   A   I   P   L   V   V   P   F   Y   S   H   S   A
```

Fig. 3B

Map of phagemid vector pABMC6

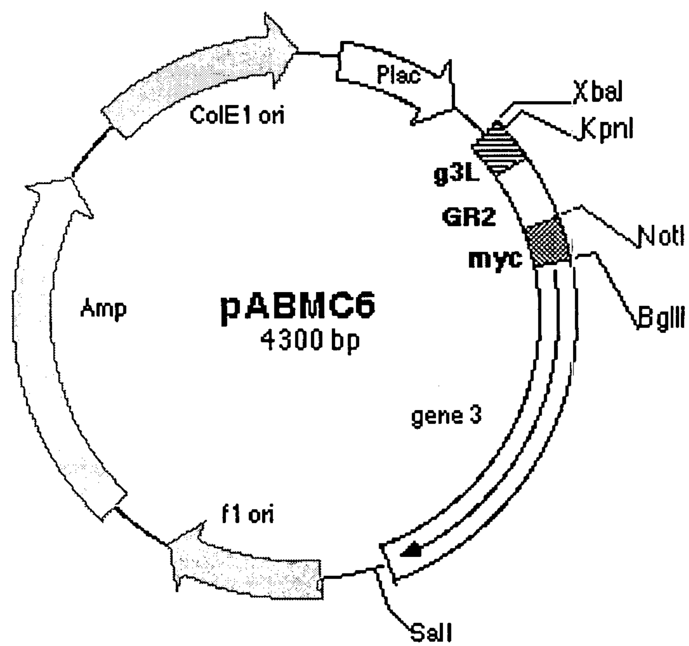


Fig. 4

Helper phage with engineered gene III fused to adaptor 2

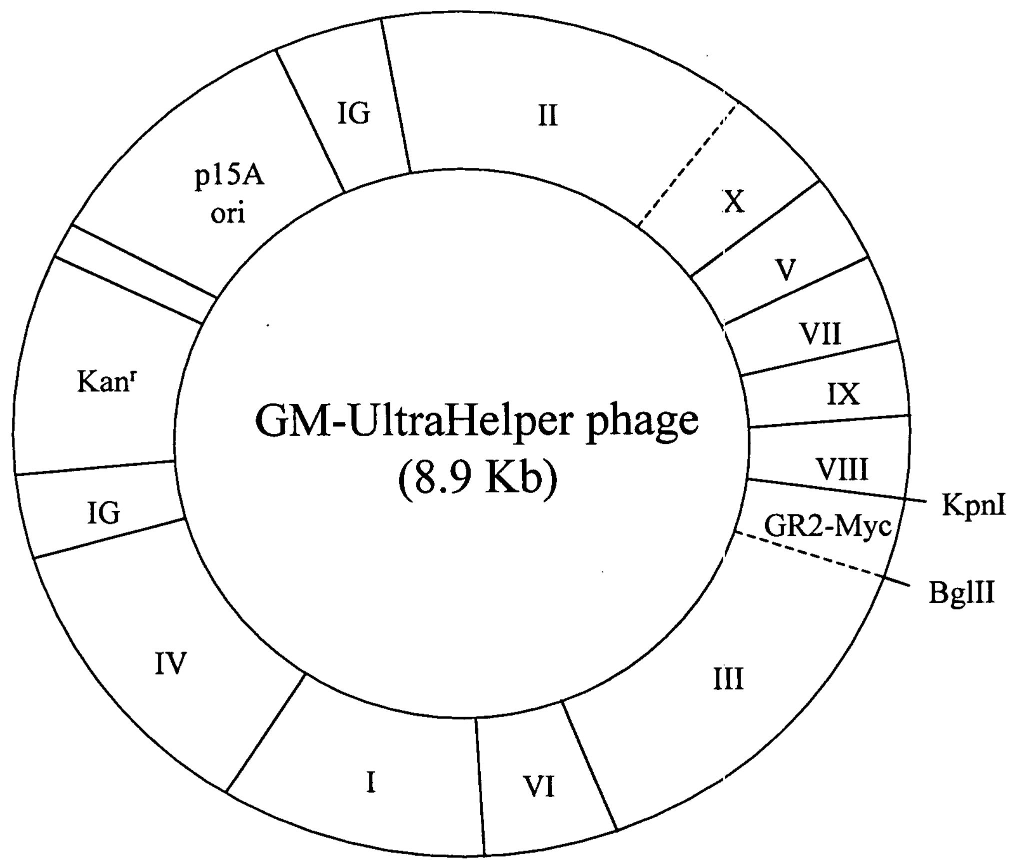


Fig. 5A

GR2-Myc domain coding sequence in GM-UltraHelper phage genome

```
     KpnI     Gene III leader                       GR2
---TTAGTGGTACCTTTCTATTCTCACTCCGCT ACATCCCGCCTGGAGGGCCTACAGTCAGAAAACCATCGCCTGCGA
 -  L  V  V  P  F  Y  S  H  S  A   T  S  R  L  E  G  L  Q  S  E  N  H  R  L  R

                                                                         NotI
ATGAAGATCACAGAGCTGGATAAAGACTTGGAAGAGGTCACCATGCAGCTGCAGGACGTCGGAGGTTGC GCGGCCGCA
 M  K  I  T  E  L  D  K  D  L  E  E  V  T  M  Q  L  Q  D  V  G  G  C   A  A  A

            Myc-tag               BglII              Gene III
GAACAAAAACTCATCTCAGAAGAGGATCTG AGATCTGGAGGCGGT ACTGTTGAAAGTTGTTTAGCAAAA---
 E  Q  K  L  I  S  E  E  D  L   R  S  G  G  G   T  V  E  S  C  L  A  K  -
```

Fig. 5B

Trypsin cleavage sites at GR2-Myc domain on GM-UltraHelper phage

GR2 domain

T S R ▲ L E G L Q S E N H R ▲ L R ▲ M K ▲ I T E L D K ▲ D L E E V

Myc-tag

T M Q L Q D V G G C A A A *E Q K* ▲ *L I S E E D L R* ▲ *S* G G G

Fig. 5C

GR2-Myc-pIII fusions assembly into GM phage particles

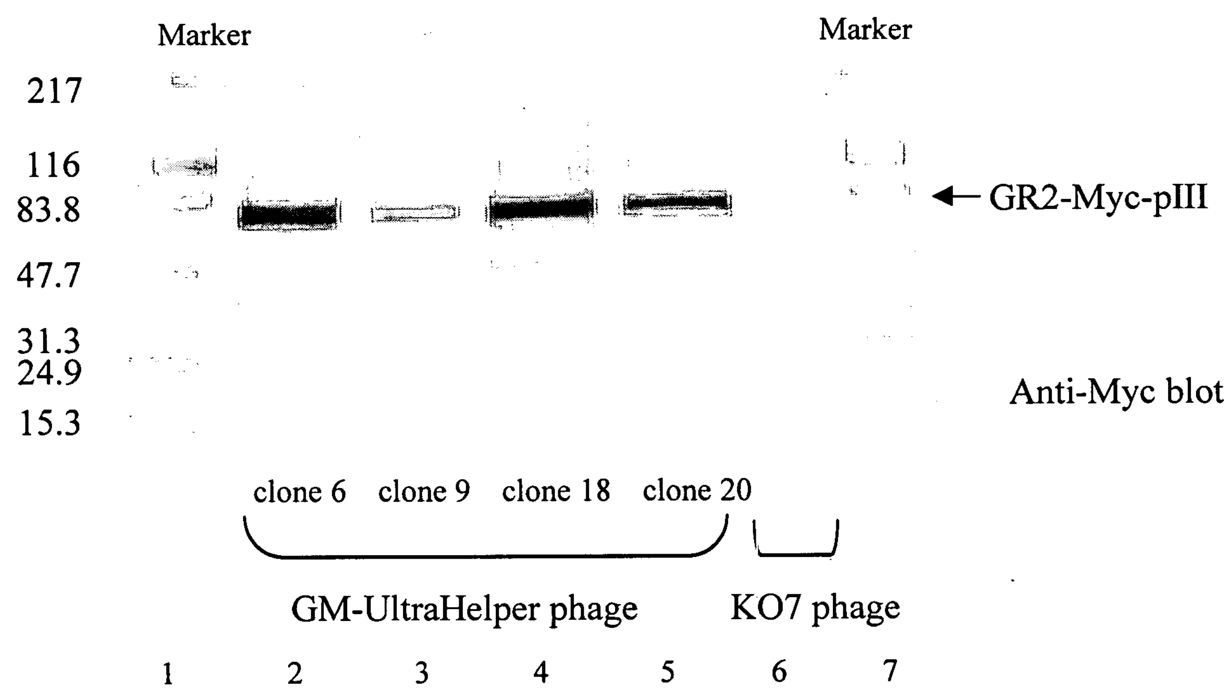


Fig. 6

Detection of GR2-Myc domain on GM-UltraHelper phage

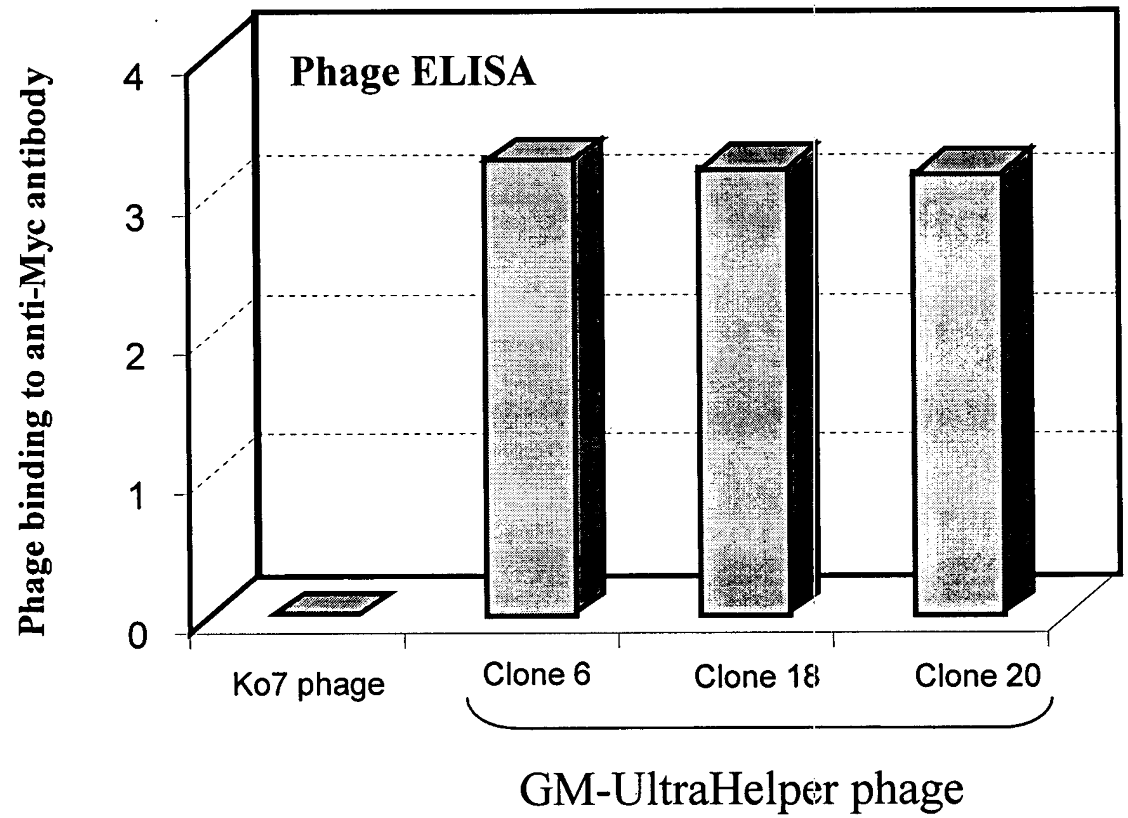


Fig. 7

Cleavage of GR2-Myc domains on GM phages by trypsin

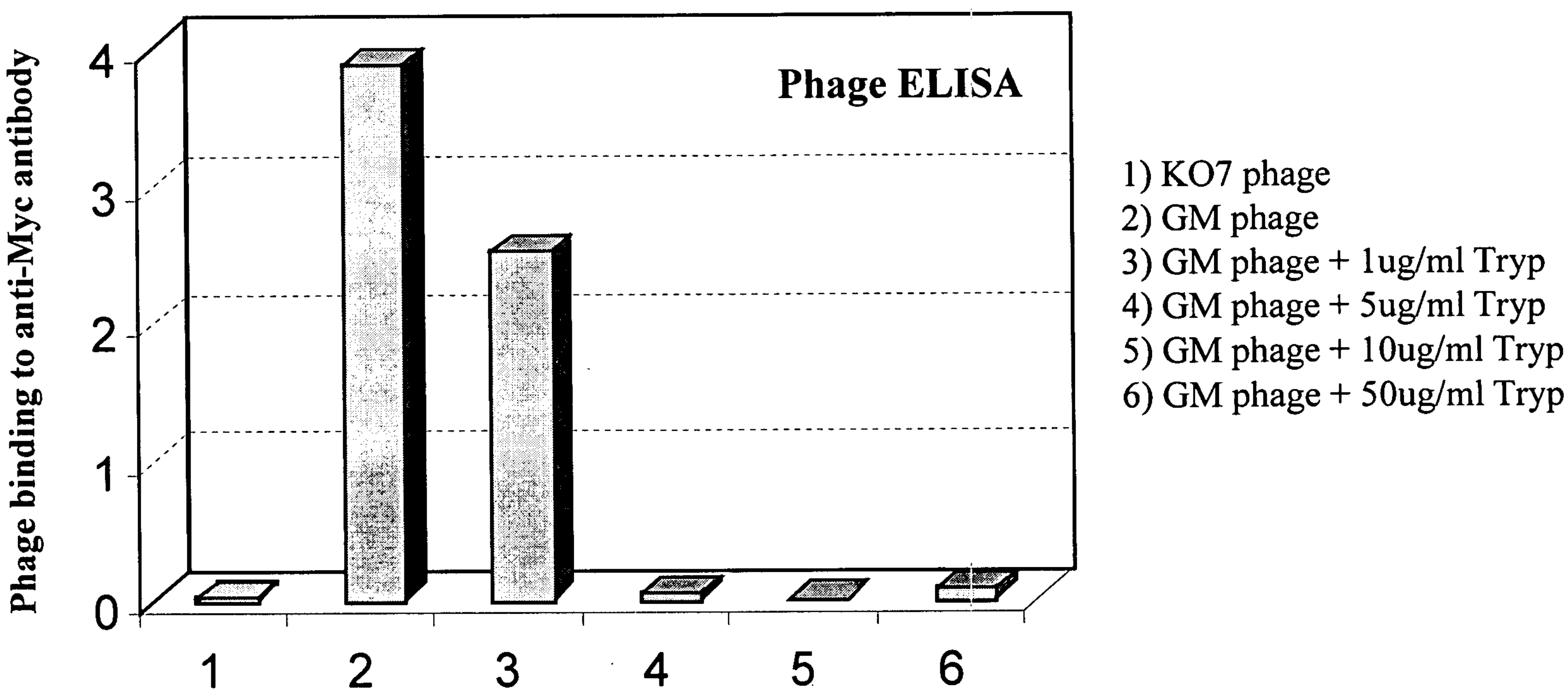


Fig. 8

Phagemid vector for protein-GR1 expression

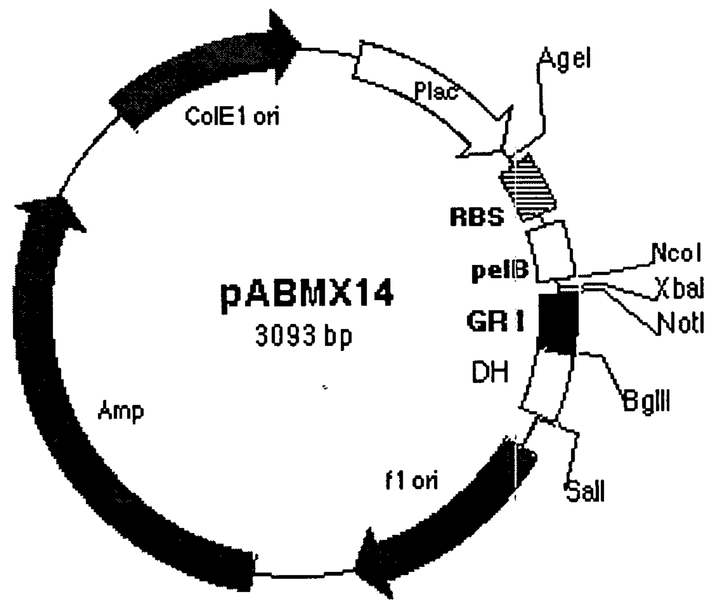


Fig. 9A

Complete vector sequence of pABMX14

GCGCAACGCAATTAATGTGAGTTAGCTCACTCATTAGGCACCCCAGGCTTTACACTTTATGCTTCCGGCTCGTATGTTGTGTGGAATTGTGAGCGGATAACAATTTACCGGTTCTTTAAGGAGGA
ATTAAAAAATGAAATACCTATTGCCTACGGCAGCCGCTGGATTGTTATTACTCGCGGCCCAGCCGGCCATGGCGGCCCTGCAGGCCTCTAGAGCGGCCGCTGGAGGTGAGGAGAAGTCCCGGCTG
TTGGAGAAGGAGAACCGTGAACTGGAAAAGATCATTGCTGAGAAAGAGGAGCGTGTCTCTGAACTGCGCCATCAACTCCAGTCTGTAGGAGGTTGTAGATCTTATCCATACGACGTACCAGACTA
CGCAGGAGGTCATCACCATCATCACCATTAATGAGTCGACCTCGACCAATTCGCCCTATAGTGAGTCGTATTACAATTCACTGGCCGTCGTTTTACAACGTCGTGACTGGGAAAACCCTGGCGTT
ACCCAACTTAATCGCCTTGCAGCACATCCCCCTTTCGCCAGCTGGCGTAATAGCGAAGAGGCCCGCACCGATCGCCCTTCCCAACAGTTGCGCAGCCTGAATGGCGAATGGGACGCGCCCTGTAG
CGGCGCATTAAGCGCGGCGGGTGTGGTGGTTACGCGCAGCGTGACCGCTACACTTGCCAGCGCCCTAGCGCCCGCTCCTTTCGCTTTCTTCCCTTCCTTTCTCGCCACGTTCGCCGGCTTTCCCC
GTCAAGCTCTAAATCGGGGGCTCCCTTTAGGGTTCCGATTTAGTGCTTTACGGCACCTCGACCCCAAAAAACTTGATTAGGGTGATGGTTCACGTAGTGGGCCATCGCCCTGATAGACGGTTTTT
CGCCCTTTGACGTTGGAGTCCACGTTCTTTAATAGTGGACTCTTGTTCCAAACTGGAACAACACTCAACCCTATCTCGGTCTATTCTTTTGATTTATAAGGGATTTTGCCGATTTCGGCCTATTG
GTTAAAAAATGAGCTGATTTAACAAAAATTTAACGCGAATTTTAACAAAATATTAACGCTTACAATTTAGGTGGCACTTTTCGGGGAAATGTGCGCGGAACCCCTATTTGTTTATTTTTCTAAAT
ACATTCAAATATGTATCCGCTCATGAGACAATAACCCTGATAAATGCTTCAATAATATTGAAAAAGGAAGAGTATGAGTATTCAACATTTCCGTGTCGCCCTTATTCCCTTTTTTGCGGCATTTT
GCCTTCCTGTTTTTGCTCACCCAGAAACGCTGGTGAAAGTAAAAGATGCTGAAGATCAGTTGGGTGCACGAGTGGGTTACATCGAACTGGATCTCAACAGCGGTAAGATCCTTGAGAGTTTTCGC
CCCGAAGAACGTTTTCCAATGATGAGCACTTTTAAAGTTCTGCTATGTGGCGCGGTATTATCCCGTATTGACGCCGGGCAAGAGCAACTCGGTCGCCGCATACACTATTCTCAGAATGACTTGGT
TGAGTACTCACCAGTCACAGAAAAGCATCTTACGGATGGCATGACAGTAAGAGAATTATGCAGTGCTGCCATAACCATGAGTGATAACACTGCGGCCAACTTACTTCTGACAACGATCGGAGGAC
CGAAGGAGCTAACCGCTTTTTTGCACAACATGGGGGATCATGTAACTCGCCTTGATCGTTGGGAACCGGAGCTGAATGAAGCCATACCAAACGACGAGCGTGACACCACGATGCCTGTAGCAATG
GCAACAACGTTGCGCAAACTATTAACTGGCGAACTACTTACTCTAGCTTCCCGGCAACAATTAATAGACTGGATGGAGGCGGATAAAGTTGCAGGACCACTTCTGCGCTCGGCCCTTCCGGCTGG
CTGGTTTATTGCTGATAAATCTGGAGCCGGTGAGCGTGGGTCTCGCGGTATCATTGCAGCACTGGGGCCAGATGGTAAGCCCTCCCGTATCGTAGTTATCTACACGACGGGGAGTCAGGCAACTA
TGGATGAACGAAATAGACAGATCGCTGAGATAGGTGCCTCACTGATTAAGCATTGGTAACTGTCAGACCAAGTTTACTCATATATACTTTAGATTGATTTAAAACTTCATTTTTAATTTAAAAGG
ATCTAGGTGAAGATCCTTTTTGATAATCTCATGACCAAAATCCCTTAACGTGAGTTTTCGTTCCACTGAGCGTCAGACCCCGTAGAAAAGATCAAAGGATCTTCTTGAGATCCTTTTTTTCTGCG
CGTAATCTGCTGCTTGCAAACAAAAAAACCACCGCTACCAGCGGTGGTTTGTTTGCCGGATCAAGAGCTACCAACTCTTTTTCCGAAGGTAACTGGCTTCAGCAGAGCGCAGATACCAAATACTG
TCCTTCTAGTGTAGCCGTAGTTAGGCCACCACTTCAAGAACTCTGTAGCACCGCCTACATACCTCGCTCTGCTAATCCTGTTACCAGTGGCTGCTGCCAGTGGCGATAAGTCGTGTCTTACCGGG
TTGGACTCAAGACGATAGTTACCGGATAAGGCGCAGCGGTCGGGCTGAACGGGGGGTTCGTGCACACAGCCCAGCTTGGAGCGAACGACCTACACCGAACTGAGATACCTACAGCGTGAGCTATG
AGAAAGCGCCACGCTTCCCGAAGGGAGAAAGGCGGACAGGTATCCGGTAAGCGGCAGGGTCGGAACAGGAGAGCGCACGAGGGAGCTTCCAGGGGGAAACGCCTGGTATCTTTATAGTCCTGTCG
GGTTTCGCCACCTCTGACTTGAGCGTCGATTTTTGTGATGCTCGTCAGGGGGGCGGAGCCTATGGAAAAACGCCAGCAACGCGGCCTTTTTACGGTTCCTGGCCTTTTGCTGGCCTTTTGCTCAC
ATGTTCTTTCCTGCGTTATCCCCTGATTCTGTGGATAACCGTATTACCGCCTTTGAGTGAGCTGATACCGCTCGCCGCAGCCGAACGACCGAGCGCAGCGAGTCAGTGAGCGAGGAAGCGGAAGA
GCGCCCAATACGCAAACCGCCTCTCCCCGCGCGTTGGCCGATTCATTAATGCAGCTGGCACGACAGGTTTCCCGACTGGAAAGCGGGCAGTGA

Fig. 9B

Functional display of scFv by GM-UltraHelper phage

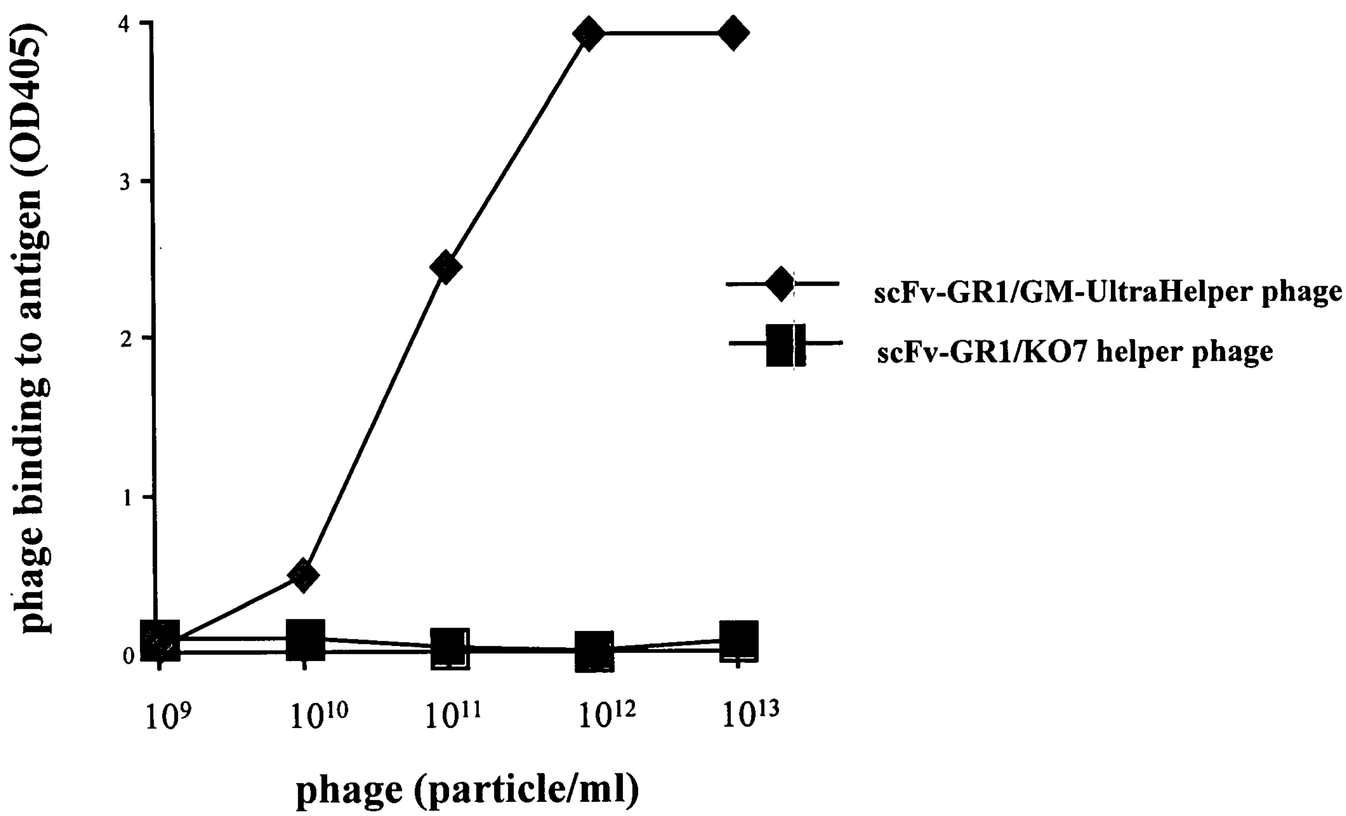


Fig. 10

Mutivalent display of scFv by GM-UltraHelper phage

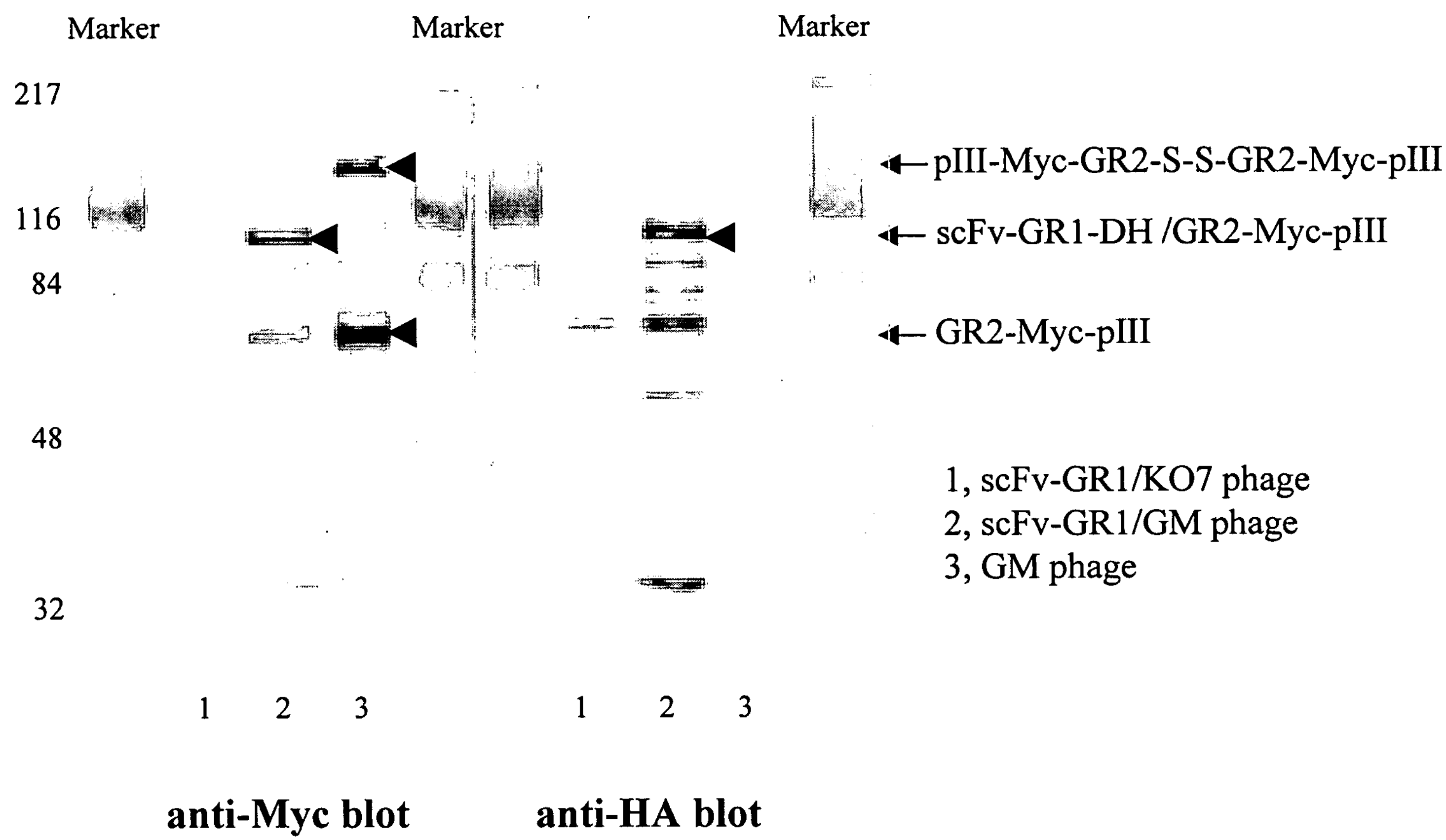


Fig. 11

Map of phagemid vector pABMC13

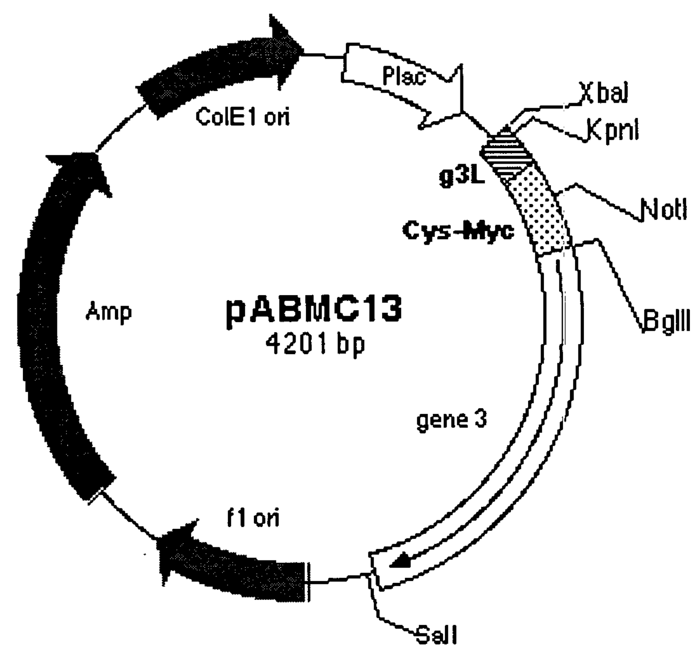


Fig. 12

Helper phage with Cys-Myc-pIII fusion gene

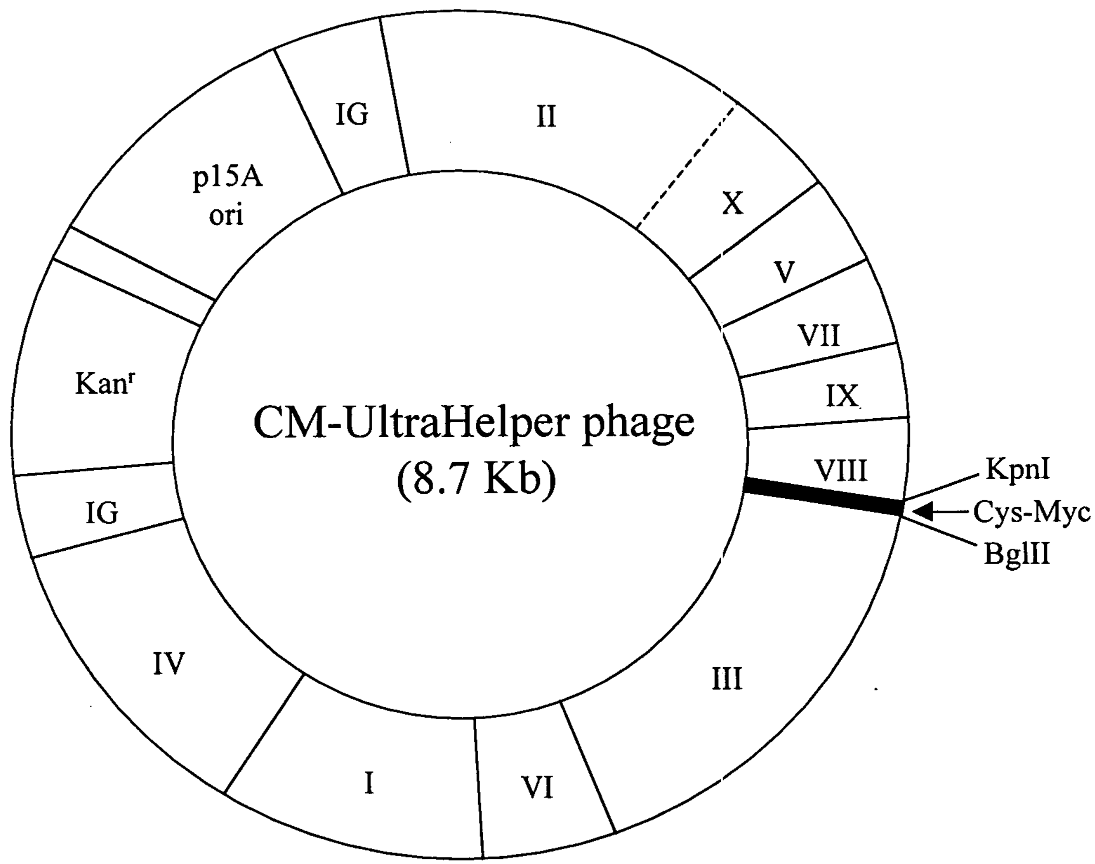


Fig. 13A

Engineered gene III sequence in CM phage

```
        KpnI  Gene III leader   Amber stop        NotI                      Myc-tag                 BglII
---TTAGTGGTACCTTTCTATTCTCACTCCGCT TAGGCTTGCGGTGGTGCGGCCGCAGAACAAAAACTCATCTCAGAAGAGGATCTGAGATCT AGATCTGGA
 -  L  V  V  P  F  Y  S  H  S  A   *  A  C  G  G  A  A  A  E  Q  K  L  I  S  E  E  D  L  R  S  R  S  G

       Gene III
GGCGGT ACTGTTGAAAGTTGTTTAGCAAAACCTCATACAGAAAATTCATTTACTAACGTCTGGAAAGACGACAAAACTTTAGATCGTTACGCT------
 G  G   T  V  E  S  C  L  A  K  P  H  T  E  N  S  F  T  N  V  W  K  D  D  K  T  L  D  R  Y  A  -  -
```

Fig. 13B

Detection of Myc-tag on CM-UltraHelper phages by ELISA

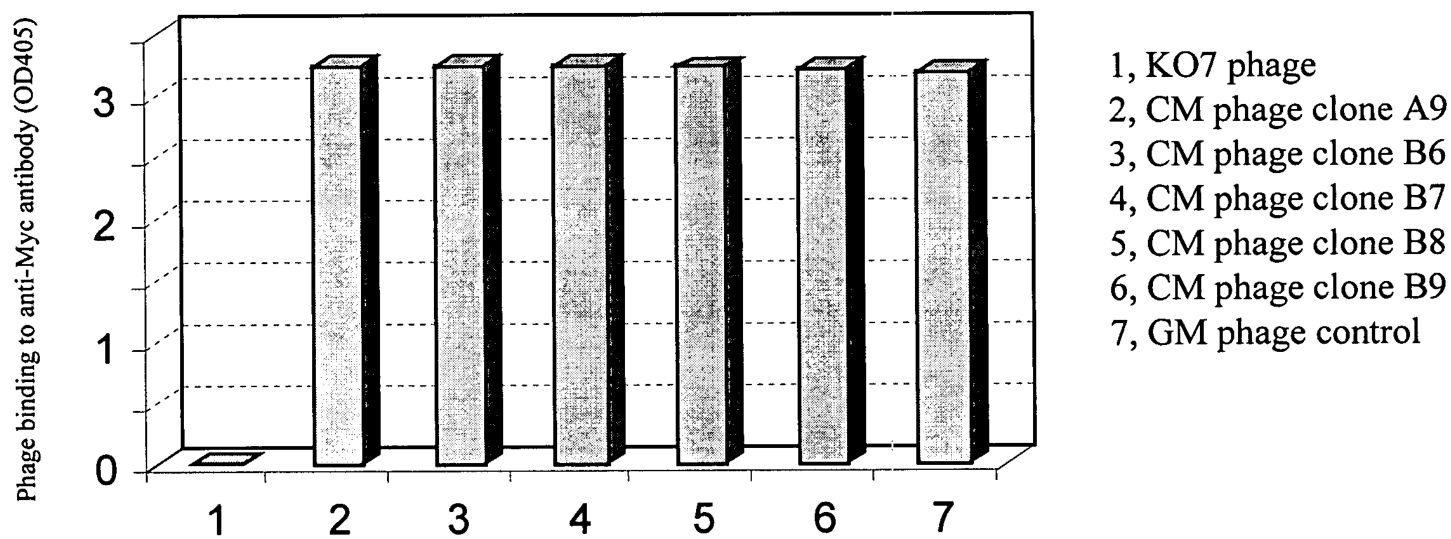


Fig. 14

Phagemid vector for protein-HA-cys expression

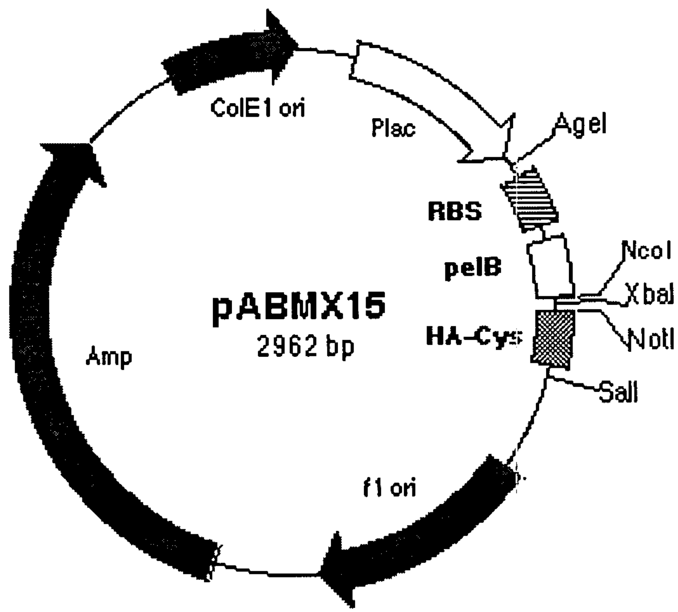


Fig. 15A

T020TT"66EEE00T

Complete vector sequence of pABMX15

GCGCAACGCAATTAATGTGAGTTAGCTCACTCATTAGGCACCCCAGGCTTTACACTTTATGCTTCCGGCTCGTATGTTGTGTGGAATTGTGAGCGGATAACAATTTACCGGTTCTTTTAACTTTAGTAAGGAGGA
ATTAAAAAATGAAATACCTATTGCCTACGGCAGCCGCTGGATTGTTATTACTCGCGGCCCAGCCGGCCATGGCGGCCCTGCAGGCCTCTAGAGCGGCCGCTTACCCGTACGACGTTCCGGACTACGCAGGTGGCT
GCTGATAAGTCGACCTCGACCAATTCGCCCTATAGTGAGTCGTATTACAATTCACTGGCCGTCGTTTTACAACGTCGTGACTGGGAAAACCCTGGCGTTACCCAACTTAATCGCCTTGCAGCACATCCCCCTTTC
GCCAGCTGGCGTAATAGCGAAGAGGCCCGCACCGATCGCCCTTCCCAACAGTTGCGCAGCCTGAATGGCGAATGGACGCGCCCTGTAGCGGCGCATTAAGCGCGGCGGGTGTGGTGGTTACGCGCAGCGTGACC
GCTACACTTGCCAGCGCCCTAGCGCCCGCTCCTTTCGCTTTCTTCCCTTCCTTTCTCGCCACGTTCGCCGGCTTTCCCCGTCAAGCTCTAAATCGGGGGCTCCCTTTAGGGTTCCGATTTAGTGCTTTACGGCAC
CTCGACCCCAAAAAACTTGATTAGGGTGATGGTTCACGTAGTGGGCCATCGCCCTGATAGACGGTTTTTCGCCCTTTGACGTTGGAGTCCACGTTCTTTAATAGTGGACTCTTGTTCCAAACTGGAACAACACTC
AACCCTATCTCGGTCTATTCTTTTGATTTATAAGGGATTTTGCCGATTTCGGCCTATTGGTTAAAAAATGAGCTGATTTAACAAAAATTTAACGCGAATTTTAACAAAATATTAACGCTTACAATTTAGGTGGCA
CTTTTCGGGGAAATGTGCGCGGAACCCCTATTTGTTTATTTTTCTAAATACATTCAAATATGTATCCGCTCATGAGACAATAACCCTGATAAATGCTTCAATAATATTGAAAAAGGAAGAGTATGAGTATTCAAC
ATTTCCGTGTCGCCCTTATTCCCTTTTTTGCGGCATTTTGCCTTCCTGTTTTTGCTCACCCAGAAACGCTGGTGAAAGTAAAAGATGCTGAAGATCAGTTGGGTGCACGAGTGGGTTACATCGAACTGGATCTCA
ACAGCGGTAAGATCCTTGAGAGTTTTCGCCCCGAAGAACGTTTTCCAATGATGAGCACTTTTAAAGTTCTGCTATGTGGCGCGGTATTATCCCGTATTGACGCCGGGCAAGAGCAACTCGGTCGCCGCATACACT
ATTCTCAGAATGACTTGGTTGAGTACTCACCAGTCACAGAAAAGCATCTTACGGATGGCATGACAGTAAGAGAATTATGCAGTGCTGCCATAACCATGAGTGATAACACTGCGGCCAACTTACTTCTGACAACGA
TCGGAGGACCGAAGGAGCTAACCGCTTTTTTGCACAACATGGGGGATCATGTAACTCGCCTTGATCGTTGGGAACCGGAGCTGAATGAAGCCATACCAAACGACGAGCGTGACACCACGATGCCTGTAGCAATGG
CAACAACGTTGCGCAAACTATTAACTGGCGAACTACTTACTCTAGCTTCCCGGCAACAATTAATAGACTGGATGGAGGCGGATAAAGTTGCAGGACCACTTCTGCGCTCGGCCCTTCCGGCTGGCTGGTTTATTG
CTGATAAATCTGGAGCCGGTGAGCGTGGGTCTCGCGGTATCATTGCAGCACTGGGGCCAGATGGTAAGCCCTCCCGTATCGTAGTTATCTACACGACGGGGAGTCAGGCAACTATGGATGAACGAAATAGACAGA
TCGCTGAGATAGGTGCCTCACTGATTAAGCATTGGTAACTGTCAGACCAAGTTTACTCATATATACTTTAGATTGATTTAAAACTTCATTTTTAATTTAAAAGGATCTAGGTGAAGATCCTTTTTGATAATCTCA
TGACCAAAATCCCTTAACGTGAGTTTTCGTTCCACTGAGCGTCAGACCCCGTAGAAAAGATCAAAGGATCTTCTTGAGATCCTTTTTTTCTGCGCGTAATCTGCTGCTTGCAAACAAAAAAACCACCGCTACCAG
CGGTGGTTTGTTTGCCGGATCAAGAGCTACCAACTCTTTTTCCGAAGGTAACTGGCTTCAGCAGAGCGCAGATACCAAATACTGTCCTTCTAGTGTAGCCGTAGTTAGGCCACCACTTCAAGAACTCTGTAGCAC
CGCCTACATACCTCGCTCTGCTAATCCTGTTACCAGTGGCTGCTGCCAGTGGCGATAAGTCGTGTCTTACCGGGTTGGACTCAAGACGATAGTTACCGGATAAGGCGCAGCGGTCGGGCTGAACGGGGGGTTCGT
GCACACAGCCCAGCTTGGAGCGAACGACCTACACCGAACTGAGATACCTACAGCGTGAGCTATGAGAAAGCGCCACGCTTCCCGAAGGGAGAAAGGCGGACAGGTATCCGGTAAGCGGCAGGGTCGGAACAGGAG
AGCGCACGAGGGAGCTTCCAGGGGGAAACGCCTGGTATCTTTATAGTCCTGTCGGGTTTCGCCACCTCTGACTTGAGCGTCGATTTTTGTGATGCTCGTCAGGGGGGCGGAGCCTATGGAAAAACGCCAGCAACG
CGGCCTTTTTACGGTTCCTGGCCTTTTGCTGGCCTTTTGCTCACATGTTCTTTCCTGCGTTATCCCCTGATTCTGTGGATAACCGTATTACCGCCTTTGAGTGAGCTGATACCGCTCGCCGCAGCCGAACGACCG
AGCGCAGCGAGTCAGTGAGCGAGGAAGCGGAAGAGCGCCCAATACGCAAACCGCCTCTCCCCGCGCGTTGGCCGATTCATTAATGCAGCTGGCACGACAGGTTTCCCGACTGGAAAGCGGGCAGTGA

Fig. 15B

Functional display of scFv by CM-UltraHelper phage

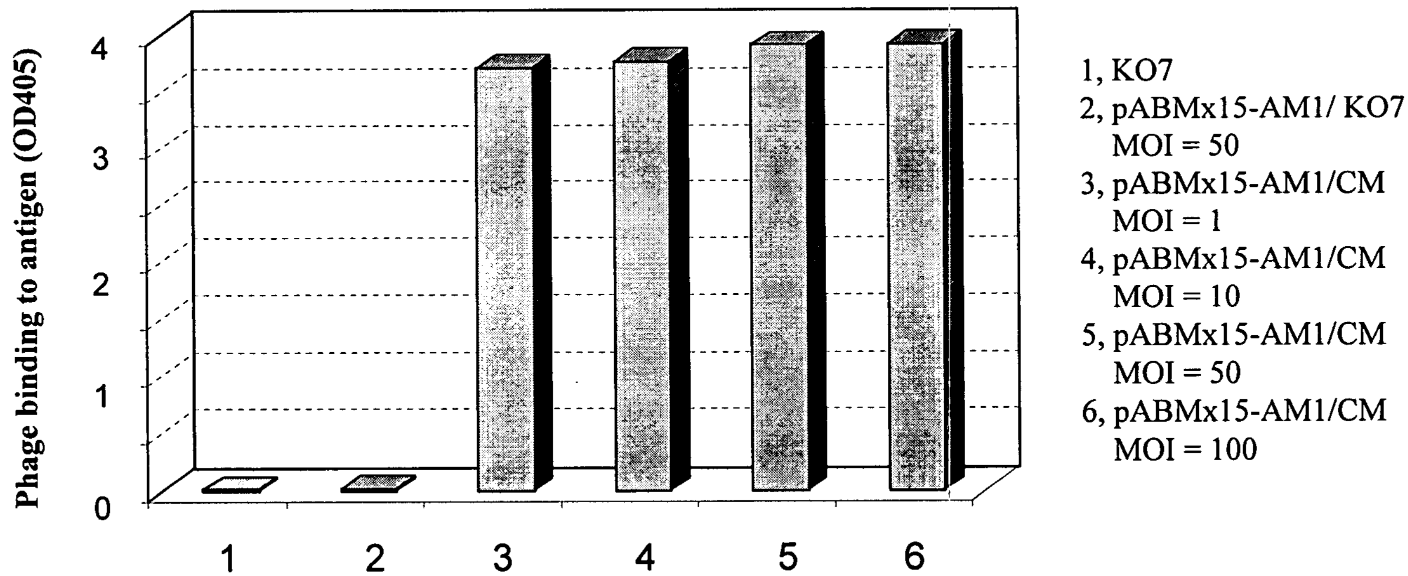
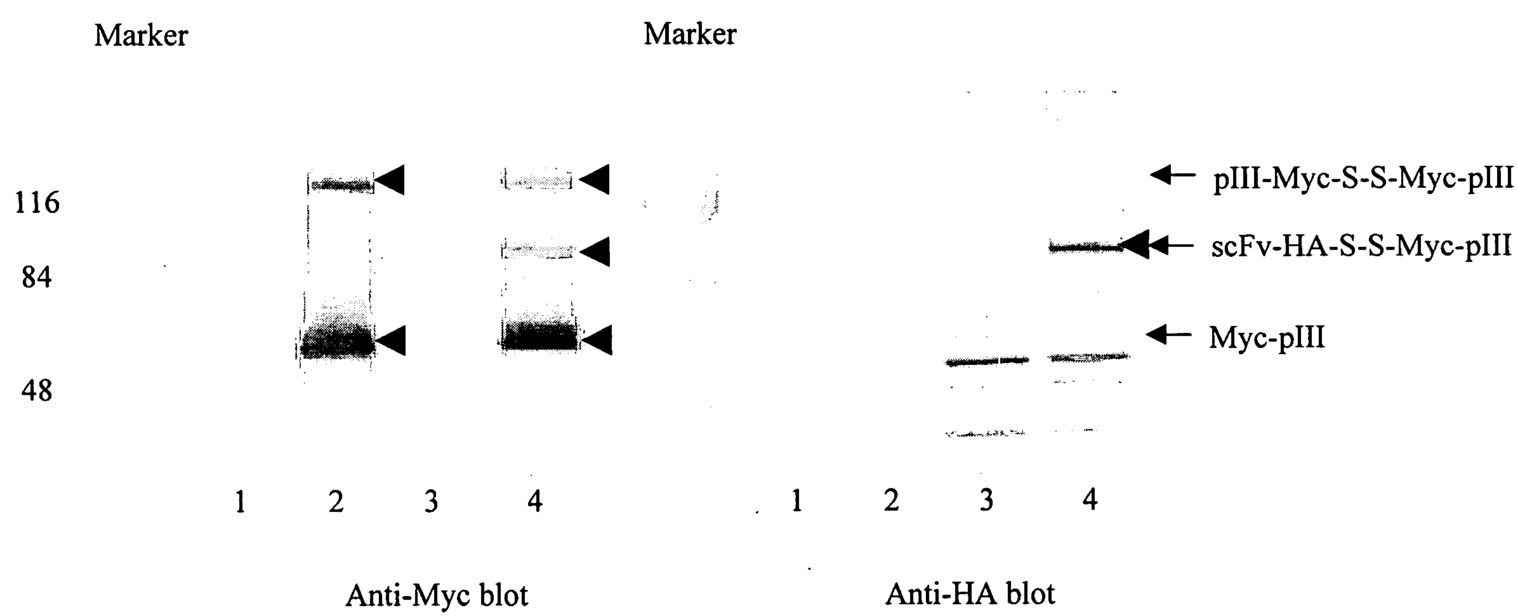


Fig. 16

Detection of scFv displayed by CM-UltraHelper phage



1: KO7 phage; 2: CM phage; 3: pABMx15-AM1/ KO7; 4: pABMx15-AM1/CM

Fig. 17

Map of phagemid vector pABMC12

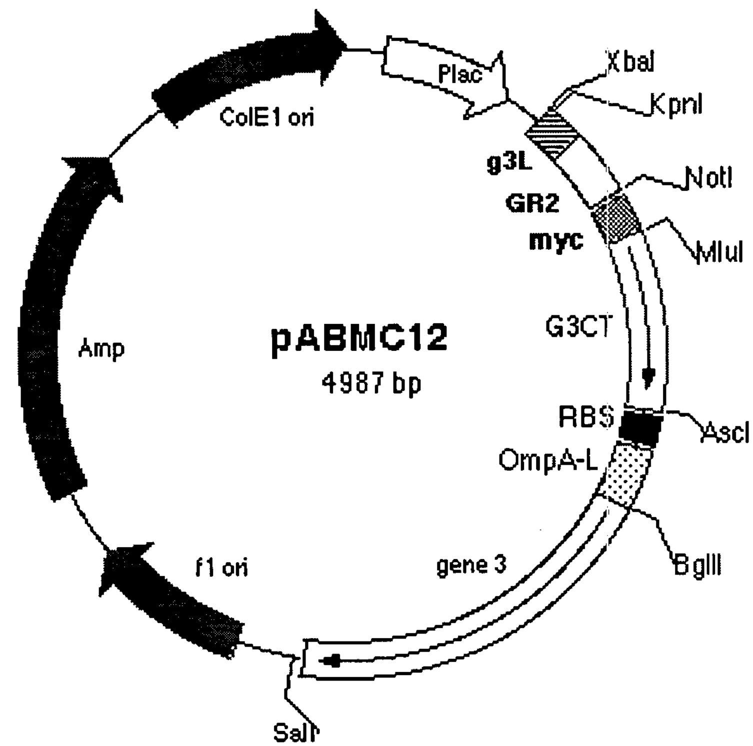


Fig. 18

Helper phage with an additional copy of engineered gene III

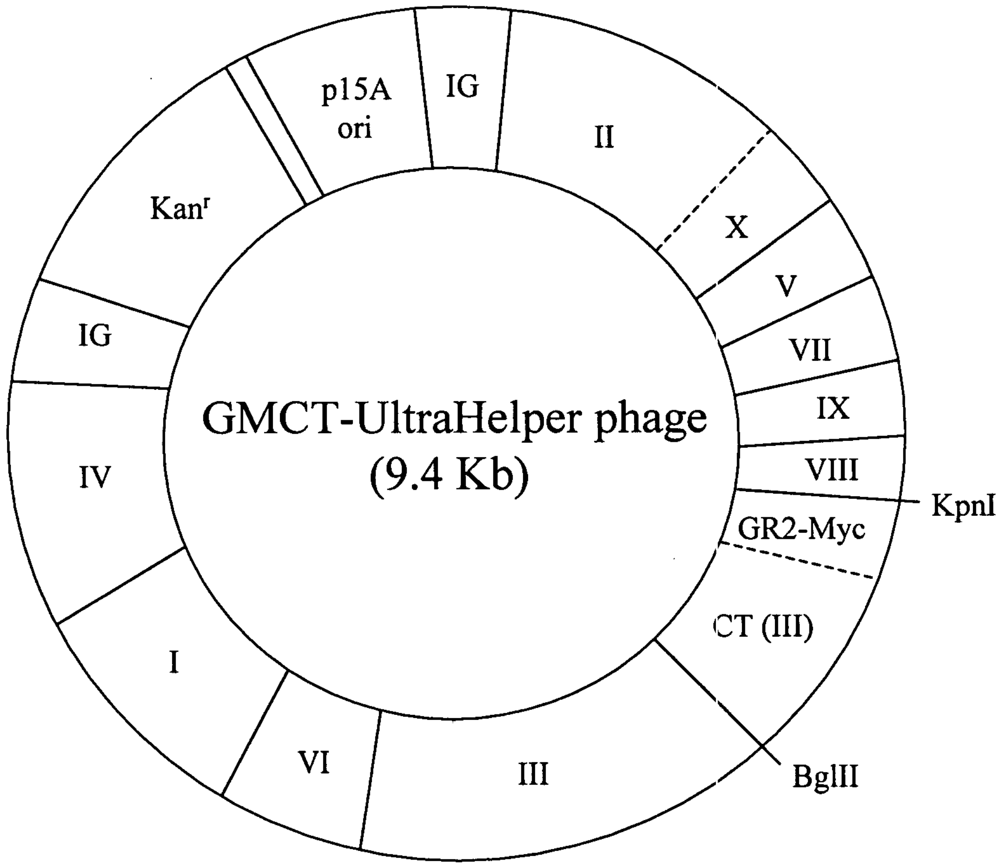


Fig. 19A

Engineered gene III Sequence in GMCT phage genome

```
     KpnI   Gene III Leader                                   GR2 domain
--TTAGTGGTACCTTTCTATTCTCACTCCGCT ACATCCCGCCTGGAGGGCCTACAGTCAGAAAACCATCGCCTGCGAATGAAGATCACAGAGCTGGATAAA
 -L  V  V  P  F  Y  S  H  S  A   T  S  R  L  E  G  L  Q  S  E  N  H  R  L  R  M  K  I  T  E  L  D  K
                                                      NotI              Myc-tag
GACTTGGAAGAGGTCACCATGCAGCTGCAGGACGTCGGAGGTTGC GCGGCCGCAGAACAAAAACTCATCTCAGAAGAGGATCTGACGCGTGCT GGCGGC
 D  L  E  E  V  T  M  Q  L  Q  D  V  G  G  C   A  A  A  E  Q  K  L  I  S  E  E  D  L  T  R  A   G  G
  CT domain of Gene III
GGCTCTGGTGGTGGTTCTGGTGGCGGCTCTGAGGGTGGCGGCTCTGAGGGTGGCGGTTCTGAGGGTGGCGGCTCTGAGGGTGGCGGTTCCGGTGGCGGCTCC
 G  S  G  G  G  S  G  G  G  S  E  G  G  G  S  E  G  G  G  S  E  G  G  G  S  E  G  G  G  S  G  G  G  S
GGTTCCGGTGATTTTGATTATGAAAAAATGGCAAACGCTAATAAGGGGGCTATGACCGAAAATGCCGATGAAAACGCGCTACAGTCTGACGCTAAAGGCAAA
 G  S  G  D  F  D  Y  E  K  M  A  N  A  N  K  G  A  M  T  E  N  A  D  E  N  A  L  Q  S  D  A  K  G  K
CTTGATTCTGTCGCTACTGATTACGGTGCTGCTATCGATGGTTTCATTGGTGACGTTTCCGGCCTTGCTAATGGTAATGGTGCTACTGGTGATTTTGCTGGC
 L  D  S  V  A  T  D  Y  G  A  A  I  D  G  F  I  G  D  V  S  G  L  A  N  G  N  G  A  T  G  D  F  A  G
TCTAATTCCCAAATGGCTCAAGTCGGTGACGGTGATAATTCACCTTTAATGAATAATTTCCGTCAATATTTACCTTCCCTCCCTCAATCGGTTGAATGTCGC
 S  N  S  Q  M  A  Q  V  G  D  G  D  N  S  P  L  M  N  N  F  R  Q  Y  L  P  S  L  P  Q  S  V  E  C  R
CCTTTTGTCTTTGGCGCTGGTAAACCATATGAATTTTCTATTGATTGTGACAAAATAAACTTATTCCGTGGTGTCTTTGCGTTTCTTTTATATGTTGCCACC
 P  F  V  F  G  A  G  K  P  Y  E  F  S  I  D  C  D  K  I  N  L  F  R  G  V  F  A  F  L  L  Y  V  A  T
                                                            AscI          S/D
TTTATGTATGTATTTTCTACGTTTGCTAACATACTGCGTAATAAGGAGTCTTAATAA GGCGCGCCACAATTTCACAGTAAGGAGGTTTAATAA ATGAAA
 F  M  Y  V  F  S  T  F  A  N  I  L  R  N  K  E  S  *  *                                       M  K
OmpA leader                                                BglII          Gene III
AAGACAGCTATTGCGATTGCAGTGGCACTGGCTGGTTTCGCTACCGTAGCGCAGGCT AGATCTGGAGGCGGT ACTGTTGAAAGTTGTTTAGCAAAA---
 K  T  A  I  A  I  A  V  A  L  A  G  F  A  T  V  A  Q  A   R  S  G  G  G   T  V  E  S  C  L  A  K  -
```

Fig. 19B

Functional display of scFv by GMCT-UltraHelper phage

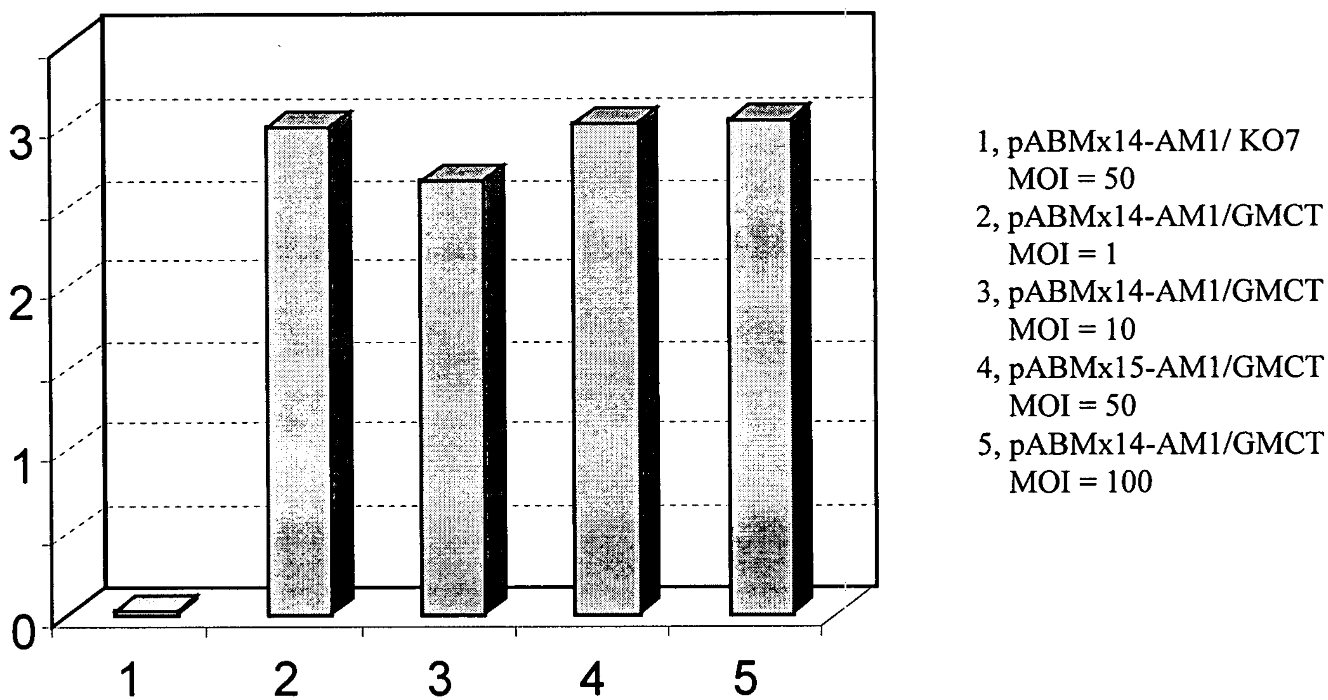


Fig. 20

Detection of scFv displayed by GMCT-UltraHelper phage

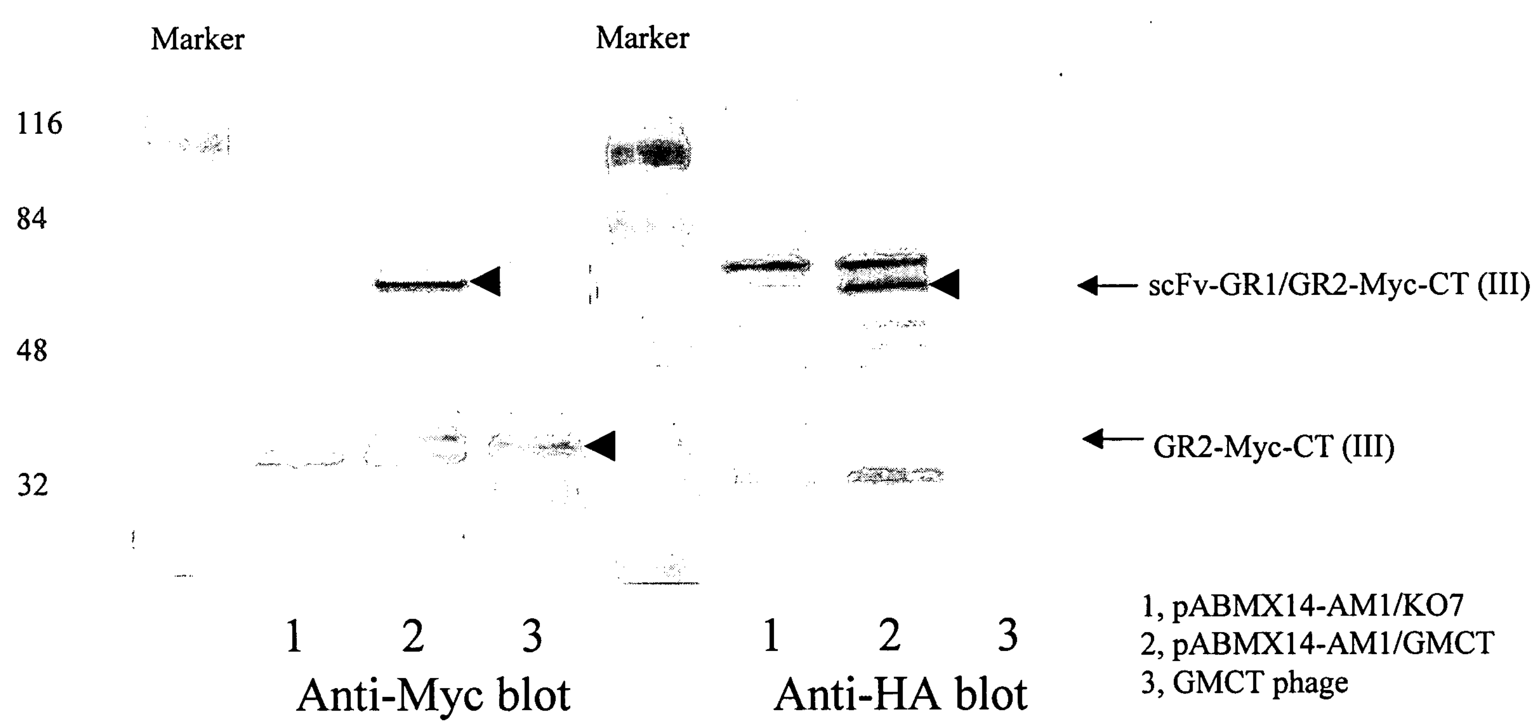
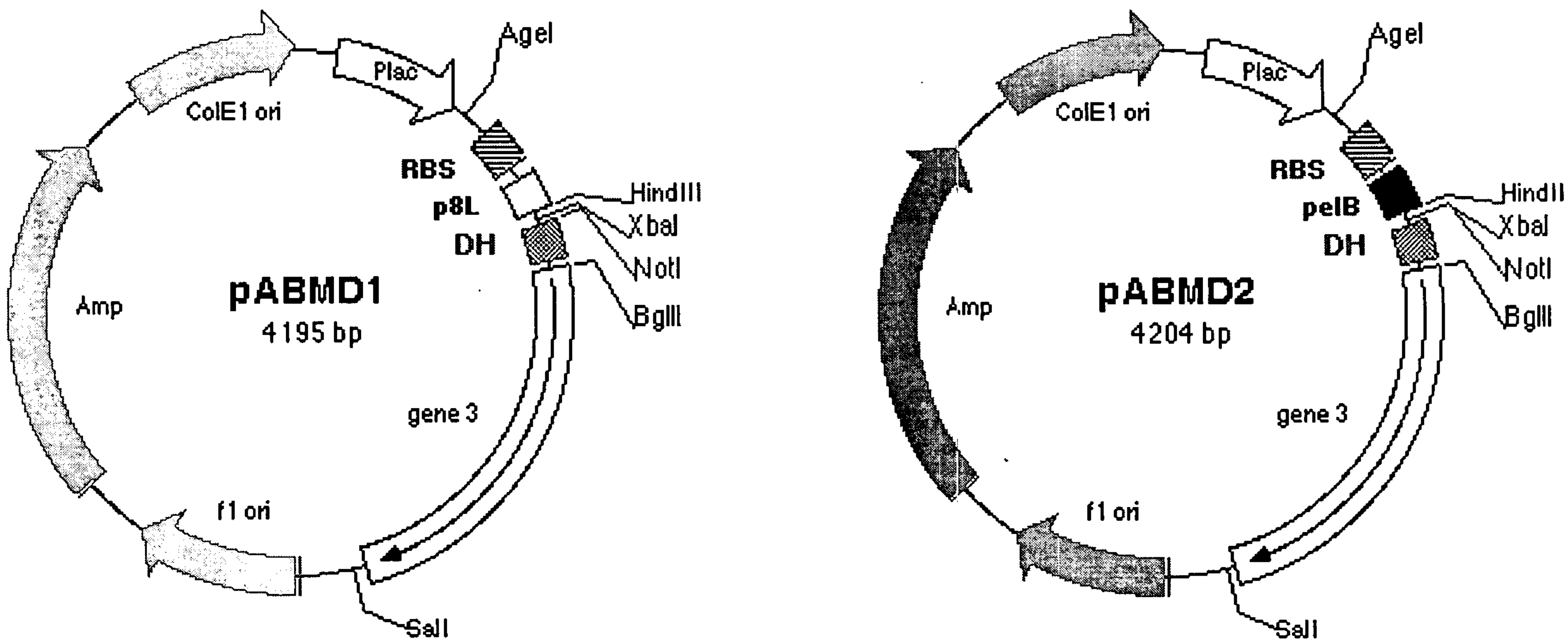


Fig. 21



Agel
Plac
ColE1 ori
RBS
p8L
DH
HindIII
XbaI
NotI
BglII
pABMD1
4195 bp
Amp
gene 3
f1 ori
SalI
Agel
Plac
ColE1 ori
RBS
pelB
DH
HindIII
XbaI
NotI
BglII
pABMD2
4204 bp
Amp
gene 3
f1 ori
SalI

Fig. 22A

PABMD1 vector: sequence from AgeI to SalI

```
   lac promoter/lac O1          AgeI                EP          S/D
AATTGTGAGCGGATAACAATTT  ACCGGT  TCTT  TTAACTTTAG  TAAGGAGG  AATTAAAAA
            P8 Leader                                                       HindIII      XbaI
ATGAAAAAGTCTTTAGTCCTCAAAGCCTCCGTAGCCGTTGCTACCCTCGTTCCGATGCTAAGCTTCGCT  TCTAGA
 M  K  K  S  L  V  L  K  A  S  V  A  V  A  T  L  V  P  M  L  S  F  A     S  R
    NotI               HA-tag                                His-tag        Amber stop  BglII
GCGGCCGCT  TATCCATACGACGTACCAGACTACGCA  GGAGGT  CATCACCATCATCACCAT   TAG    AGATCT
 A  A  A    Y  P  Y  D  V  P  D  Y  A   G  G   H  H  H  H  H  H     *      R  S
                         Gene 3                                                 SalI
GGAGGCGGT  ACTGTTGAAAGTTGTTTAGCAAAA  ----  GCTAACATACTGCGTAATAAGGAGTCTTAA  GTCGAC
 G  G  G    T  V  E  S  C  L  A  K   ----   A  N  I  L  R  N  K  E  S  *
```

PABMD2 vector: sequence from AgeI to SalI

```
   lac promoter/lac O1          AgeI              EP            S/D
AATTGTGAGCGGATAACAATTT  ACCGGT  TCTT  TTAACTTTAG  TAAGGAGG  AATTAAAAA
            pelB Leader                                                  Nco I          PstI        XbaI
ATGAAATACCTATTGCCTACGGCAGCCGCTGGATTGTTATTACTCGCGGCCCAGCCGGCCATGGCGGCCCTGCAGGCCTCTAGA
 M  K  Y  L  L  P  T  A  A  A  G  L  L  L  L  A  A  Q  P  A  M  A  A  L  Q  A  S  R
    NotI               HA-tag                                His-tag        Amber stop  BglII
GCGGCCGCT  TATCCATACGACGTACCAGACTACGCA  GGAGGT  CATCACCATCATCACCAT   TAG    AGATCT
 A  A  A    Y  P  Y  D  V  P  D  Y  A   G  G   H  H  H  H  H  H     *      R  S
                         Gene 3                                                 SalI
GGAGGCGGT  ACTGTTGAAAGTTGTTTAGCAAAA  ----  GCTAACATACTGCGTAATAAGGAGTCTTAA  GTCGAC
 G  G  G    T  V  E  S  C  L  A  K   ----   A  N  I  L  R  N  K  E  S  *
```

Fig. 22B

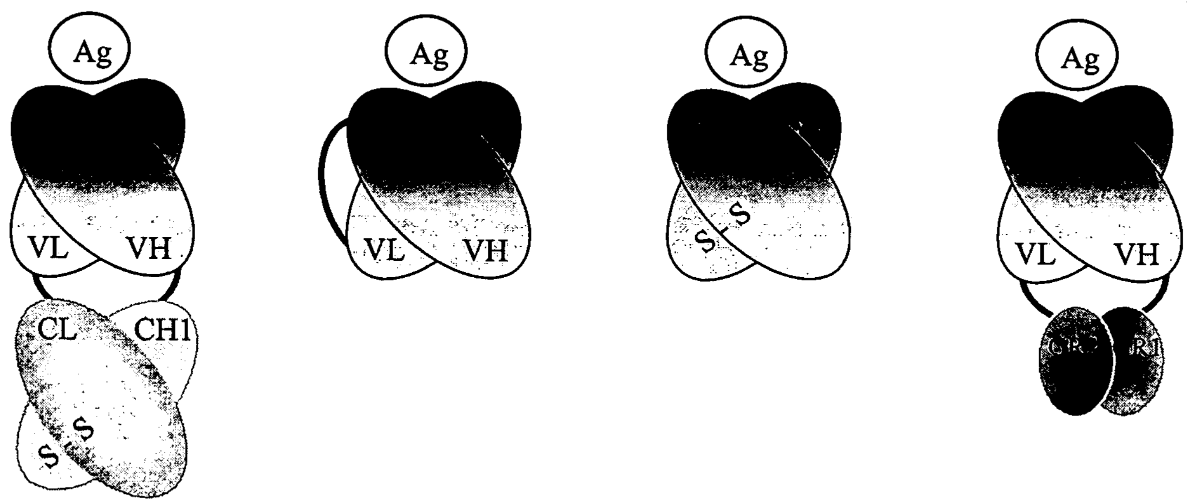
GR1 Sequence Range: 1 to 146

```
XbaI     10        20        30        40        50
TCTAGAGGTGGAGGAGGTGAGGAGAAGTCCCGGCTGTTGGAGAAGGAGAA
 S  R  G  G  G  G  E  E  K  S  R  L  L  E  K  E  N
         60        70        80        90       100
CCGTGAACTGGAAAAGATCATTGCTGAGAAAGAGGAGCGTGTCTCTGAAC
  R  E  L  E  K  I  I  A  E  K  E  E  R  V  S  E
        110       120       130       140  AscI
TGCGCCATCAACTCCAGTCTGTAGGAGGTTGTTAATAGGGCGCGCC
L  R  H  Q  L  Q  S  V  G  G  C  *  *
```

GR2 Sequence Range: 1 to 140

```
 XhoI    10        20        30        40        50
TCTCGAGGAGGTGGTGGAACATCCCGCCTGGAGGGCCTACAGTCAGAAAA
 S  R  G  G  G  G  T  S  R  L  E  G  L  Q  S  E  N
         60        70        80        90       100
CCATCGCCTGCGAATGAAGATCACAGAGCTGGATAAAGACTTGGAAGAGG
  H  R  L  R  M  K  I  T  E  L  D  K  D  L  E  E
        110       120       130  NotI 140
TCACCATGCAGCTGCAGGACGTCGGAGGTTGCGCGGCCGC
V  T  M  Q  L  Q  D  V  G  G  C  A  A  A
```

Fig. 23



Fab

scFv
single-chain Fv

dsFv
disulfide- stabilized Fv

ccFv
heterodimeric coiled-coil stabilized Fv

Ag antigen

Fig. 24

Expression vector for Adapter-directed bacterial display

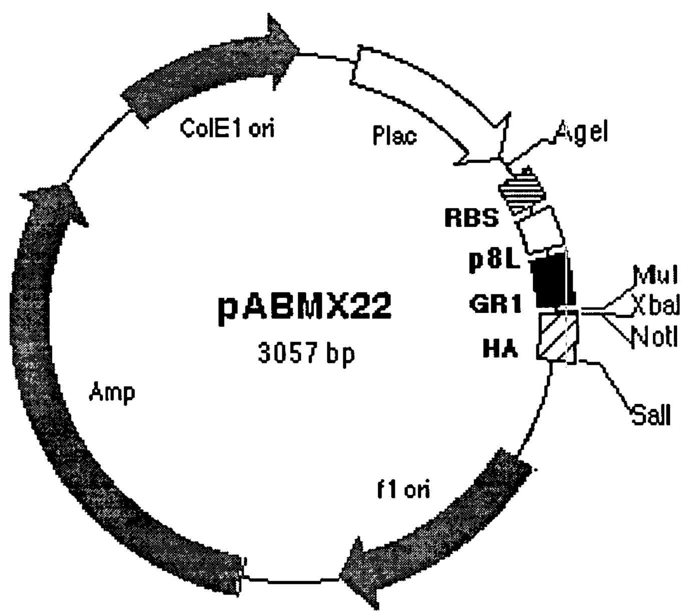


Fig. 25A

Complete vector sequence of pABMX22

GCGCAACGCAATTAATGTGAGTTAGCTCACTCATTAGGCACCCCAGGCTTTACACTTTATGCTTCCGGCTCGTATGTTGTGTGGAATTGTGAGCGGATAACAATTTACCGGTTCTTTAAGGAGGAATT
AAAAAATGAAAAAGTCTTTAGTCCTCAAAGCCTCCGTAGCCGTTGCTACCCTCGTTCCGATGCTAAGCTTCGCTGGTGAGGAAAAGTCCCGTCTGCTGGAGAAAGAGAACCGTGAACTGGAAAAGATC
ATTGCTGAGAAAGAGGAGCGTGTTTCTGAACTGCGCCATCAACTGCAGTCTGTAGGCGGTTGCACGCGTTCTAGAGCGGCCGCTTACCCGTACGACGTTCCGGACTACGCATGATAAGTCGACCTCGA
CCAATTCGCCCTATAGTGAGTCGTATTACAATTCACTGGCCGTCGTTTTACAACGTCGTGACTGGGAAAACCCTGGCGTTACCCAACTTAATCGCCTTGCAGCACATCCCCCTTTCGCCAGCTGGCGT
AATAGCGAAGAGGCCCGCACCGATCGCCCTTCCCAACAGTTGCGCAGCCTGAATGGCGAATGGGACGCGCCCTGTAGCGGCGCATTAAGCGCGGCGGGTGTGGTGGTTACGCGCAGCGTGACCGCTAC
ACTTGCCAGCGCCCTAGCGCCCGCTCCTTTCGCTTTCTTCCCTTCCTTTCTCGCCACGTTCGCCGGCTTTCCCCGTCAAGCTCTAAATCGGGGGCTCCCTTTAGGGTTCCGATTTAGTGCTTTACGGC
ACCTCGACCCCAAAAAACTTGATTAGGGTGATGGTTCACGTAGTGGGCCATCGCCCTGATAGACGGTTTTTCGCCCTTTGACGTTGGAGTCCACGTTCTTTAATAGTGGACTCTTGTTCCAAACTGGA
ACAACACTCAACCCTATCTCGGTCTATTCTTTTGATTTATAAGGGATTTTGCCGATTTCGGCCTATTGGTTAAAAAATGAGCTGATTTAACAAAAATTTAACGCGAATTTTAACAAAATATTAACGCT
TACAATTTAGGTGGCACTTTTCGGGGAAATGTGCGCGGAACCCCTATTTGTTTATTTTTCTAAATACATTCAAATATGTATCCGCTCATGAGACAATAACCCTGATAAATGCTTCAATAATATTGAAA
AAGGAAGAGTATGAGTATTCAACATTTCCGTGTCGCCCTTATTCCCTTTTTTGCGGCATTTTGCCTTCCTGTTTTTGCTCACCCAGAAACGCTGGTGAAAGTAAAAGATGCTGAAGATCAGTTGGGTG
CACGAGTGGGTTACATCGAACTGGATCTCAACAGCGGTAAGATCCTTGAGAGTTTTCGCCCCGAAGAACGTTTTCCAATGATGAGCACTTTTAAAGTTCTGCTATGTGGCGCGGTATTATCCCGTATT
GACGCCGGGCAAGAGCAACTCGGTCGCCGCATACACTATTCTCAGAATGACTTGGTTGAGTACTCACCAGTCACAGAAAAGCATCTTACGGATGGCATGACAGTAAGAGAATTATGCAGTGCTGCCAT
AACCATGAGTGATAACACTGCGGCCAACTTACTTCTGACAACGATCGGAGGACCGAAGGAGCTAACCGCTTTTTTGCACAACATGGGGGATCATGTAACTCGCCTTGATCGTTGGGAACCGGAGCTGA
ATGAAGCCATACCAAACGACGAGCGTGACACCACGATGCCTGTAGCAATGGCAACAACGTTGCGCAAACTATTAACTGGCGAACTACTTACTCTAGCTTCCCGGCAACAATTAATAGACTGGATGGAG
GCGGATAAAGTTGCAGGACCACTTCTGCGCTCGGCCCTTCCGGCTGGCTGGTTTATTGCTGATAAATCTGGAGCCGGTGAGCGTGGGTCTCGCGGTATCATTGCAGCACTGGGGCCAGATGGTAAGCC
CTCCCGTATCGTAGTTATCTACACGACGGGGAGTCAGGCAACTATGGATGAACGAAATAGACAGATCGCTGAGATAGGTGCCTCACTGATTAAGCATTGGTAACTGTCAGACCAAGTTTACTCATATA
TACTTTAGATTGATTTAAAACTTCATTTTTAATTTAAAAGGATCTAGGTGAAGATCCTTTTTGATAATCTCATGACCAAAATCCCTTAACGTGAGTTTTCGTTCCACTGAGCGTCAGACCCCGTAGAA
AAGATCAAAGGATCTTCTTGAGATCCTTTTTTTCTGCGCGTAATCTGCTGCTTGCAAACAAAAAAACCACCGCTACCAGCGGTGGTTTGTTTGCCGGATCAAGAGCTACCAACTCTTTTTCCGAAGGT
AACTGGCTTCAGCAGAGCGCAGATACCAAATACTGTCCTTCTAGTGTAGCCGTAGTTAGGCCACCACTTCAAGAACTCTGTAGCACCGCCTACATACCTCGCTCTGCTAATCCTGTTACCAGTGGCTG
CTGCCAGTGGCGATAAGTCGTGTCTTACCGGGTTGGACTCAAGACGATAGTTACCGGATAAGGCGCAGCGGTCGGGCTGAACGGGGGGTTCGTGCACACAGCCCAGCTTGGAGCGAACGACCTACACC
GAACTGAGATACCTACAGCGTGAGCTATGAGAAAGCGCCACGCTTCCCGAAGGGAGAAAGGCGGACAGGTATCCGGTAAGCGGCAGGGTCGGAACAGGAGAGCGCACGAGGGAGCTTCCAGGGGGAAA
CGCCTGGTATCTTTATAGTCCTGTCGGGTTTCGCCACCTCTGACTTGAGCGTCGATTTTTGTGATGCTCGTCAGGGGGGCGGAGCCTATGGAAAAACGCCAGCAACGCGGCCTTTTTACGGTTCCTGG
CCTTTTGCTGGCCTTTTGCTCACATGTTCTTTCCTGCGTTATCCCCTGATTCTGTGGATAACCGTATTACCGCCTTTGAGTGAGCTGATACCGCTCGCCGCAGCCGAACGACCGAGCGCAGCGAGTCA
GTGAGCGAGGAAGCGGAAGAGCGCCCAATACGCAAACCGCCTCTCCCCGCGCGTTGGCCGATTCATTAATGCAGCTGGCACGACAGGTTTCCCGACTGGAAAGCGGGCAGTGA

Fig. 25B

Helper vector for adapter-directed bacterial display

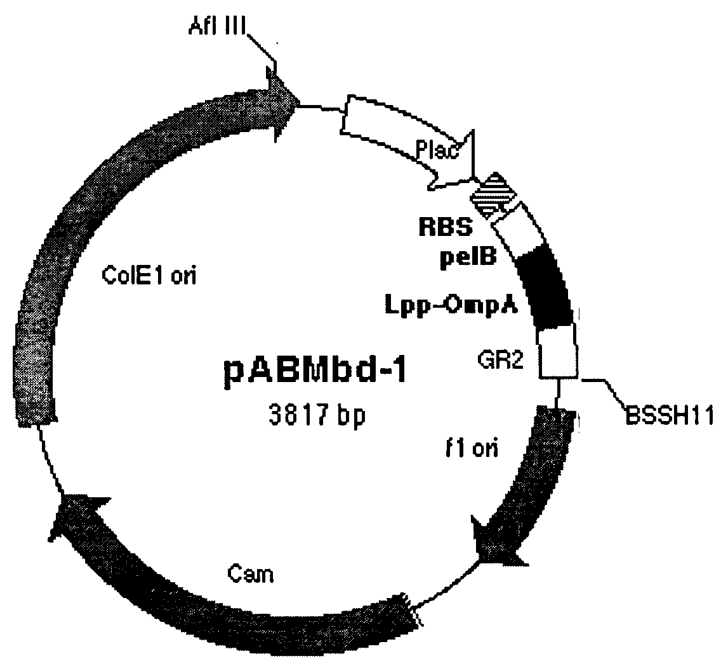


Fig. 26A

Complete vector sequence of pABMXbd-1

GCGCAACGCAATTAATGTGAGTTAGCTCACTCATTAGGCACCCCAGGCTTTACACTTTATGCTTCCGGCTCGTATGTTGTGTGGAATTGTGAGCGGATAACAATTTCACACAGGAAACAGCTATGACCA
TGATTACGCCAAGCGCGTTTAACTTTAGTAAGGAGGAATTAAAAAATGAAATACCTGCTGCCGACCGCAGCCGCGGGTTTGCTGTTACTGGCGGCCCAGCCGGCTATGGCGATGAAAGCTACTAAACTG
GTACTGGGCAACCCGTATGTTGGCTTTGAAATGGGTTACGACTGGTTAGGTCGTATGCCGTACAAAGGCAGCGTTGAAAACGGTGCATACAAAGCTCAGGGCGTTCAACTGACCGCTAAACTGGGTTAC
CCAATCACTGACGACCTGGACATCTACACTCGTCTGGGTGGCATGGTATGGCGTGCAGACACTAAATCCAACGTTTATGGTAAAAACCACGACACCGGCGTTTCTCCGGTCTTCGCTGGCGGTGTTGAG
TACGCGATCACTCCTGAAATCGCTACCCGTCTGGAATACCAGTGGACGAACAACATCGGTGACGCACACACCATCGGCACTCGTCCGGACGGAGGTACATCCCGCCTGGAGGGCCTACAGTCAGAAAAC
CATCGCCTGCGAATGAAGATCACAGAGCTGGATAAAGACTTGGAAGAAGTCACCATGCAGCTGCAAGACGTTGGCGGTTGCTAATGAGCGCGCTCACTGGCCGTCGTTTTACAACGTCGTGACTGGGAA
AACCCTGGCGTTACCCAACTTAATCGCCTTGCAGCACATCCCCCTTTCGCCAGCTGGCGTAATAGCGAAGAGGCCCGCACCGATCGCCCTTCCCAACAGTTGCGCAGCCTGAATGGCGAATGGGACGCG
CCCTGTAGCGGCGCATTAAGCGCGGCGGGTGTGGTGGTTACGCGCAGCGTGACCGCTACACTTGCCAGCGCCCTAGCGCCCGCTCCTTTCGCTTTCTTCCCTTCCTTTCTCGCCACGTTCGCCGGCTTT
CCCCGTCAAGCTCTAAATCGGGGGCTCCCTTTAGGGTTCCGATTTAGTGCTTTACGGCACCTCGACCCCAAAAAACTTGATTAGGGTGATGGTTCACGTAGTGGGCCATCGCCCTGATAGACGGTTTTT
CGCCCTTTGACGTTGGAGTCCACGTTCTTTAATAGTGGACTCTTGTTCCAAACTGGAACAACACTCAACCCTATCTCGGTCTATTCTTTTGATTTATAAGGGATTTTGCCGATTTCGGCCTATTGGTTA
AAAAATGAGCTGATTTAACAAAAATTTAACGCGAATTTTAACAAAATATTAACGCTTACAATTTAGGTGGCACTTTTCGGGGAAATGTGCGCGGAACCCCTATTTGTTTATTTTTCTAAATACATTCAA
ATATGTATCCGCTCATGAGACAATAACCCTGATAAATGCTTCAATAATATTGAAAAAGGAAGAGTATGAGTATTCAACATTTCCGTGTCGCCCTTATTCCCTTTTTTGCGGCATTTTGCCTTCCTGTTT
TTGCTCACCCAGAAACGCTGGTGAAAGTAAAAGATGCTGAAGATCAGTTGGGTGCACGAGTGGGTTACATCGAACTGGATCTCAACAGCGGTAAGATCCTTGAGAGTTTTCGCCCCGAAGAACGTTTTC
CAATGATGAGCACTTTTCGACCGAATAAATACCTGTGACGGAAGATCACTTCGCAGAATAAATAAATCCTGGTGTCCCTGTTGATACCGGGAAGCCCTGGGCCAACTTTTGGCGAAAATGAGACGTTGA
TCGGCACGTAAGAGGTTCCAACTTTCACCATAATGAAATAAGATCACTACCGGGCGTATTTTTTGAGTTGTCGAGATTTTCAGGAGCTAAGGAAGCTAAAATGGAGAAAAAAATCACTGGATATACCAC
CGTTGATATATCCCAATGGCATCGTAAAGAACATTTTGAGGCATTTCAGTCAGTTGCTCAATGTACCTATAACCAGACCGTTCAGCTGGATATTACGGCCTTTTTAAAGACCGTAAAGAAAAATAAGCA
CAAGTTTTATCCGGCCTTTATTCACATTCTTGCCCGCCTGATGAATGCTCATCCGGAATTACGTATGGCAATGAAAGACGGTGAGCTGGTGATATGGGATAGTGTTCACCCTTGTTACACCGTTTTCCA
TGAGCAAACTGAAACGTTTTCATCGCTCTGGAGTGAATACCACGACGATTTCCGGCAGTTTCTACACATATATTCGCAAGATGTGGCGTGTTACGGTGAAAACCTGGCCTATTTCCCTAAAGGGTTTAT
TGAGAATATGTTTTTCGTCTCAGCCAATCCCTGGGTGAGTTTCACCAGTTTTGATTTAAACGTGGCCAATATGGACAACTTCTTCGCCCCCGTTTTCACCATGGGCAAATATTATACGCAAGGCGACAAG
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TTCTGCGCGTAATCTGCTGCTTGCAAACAAAAAAACCACCGCTACCAGCGGTGGTTTGTTTGCCGGATCAAGAGCTACCAACTCTTTTTCCGAAGGTAACTGGCTTCAGCAGAGCGCAGATACCAAATA
CTGTCCTTCTAGTGTAGCCGTAGTTAGGCCACCACTTCAAGAACTCTGTAGCACCGCCTACATACCTCGCTCTGCTAATCCTGTTACCAGTGGCTGCTGCCAGTGGCGATAAGTCGTGTCTTACCGGGT
TGGACTCAAGACGATAGTTACCGGATAAGGCGCAGCGGTCGGGCTGAACGGGGGGTTCGTGCACACAGCCCAGCTTGGAGCGAACGACCTACACCGAACTGAGATACCTACAGCGTGAGCTATGAGAAA
GCGCCACGCTTCCCGAAGGGAGAAAGGCGGACAGGTATCCGGTAAGCGGCAGGGTCGGAACAGGAGAGCGCACGAGGGAGCTTCCAGGGGGAAACGCCTGGTATCTTTATAGTCCTGTCGGGTTTCGCC
ACCTCTGACTTGAGCGTCGATTTTTGTGATGCTCGTCAGGGGGGCGGAGCCTATGGAAAAACGCCAGCAACGCGGCCTTTTTACGGTTCCTGGCCTTTTGCTGGCCTTTTGCTCACATGTTCTTTCCTG
CGTTATCCCCTGATTCTGTGGATAACCGTATTACCGCCTTTGAGTGAGCTGATACCGCTCGCCGCAGCCGAACGACCGAGCGCAGCGAGTCAGTGAGCGAGGAAGCGGAAGAGCGCCCAATACGCAAAC
CGCCTCTCCCCGCGCGTTGGCCGATTCATTAATGCAGCTGGCACGACAGGTTTCCCGACTGGAAAGCGGGCAGTGA

Fig. 26B